FOREST SERVICE HANDBOOK
ROCKY MOUNTAIN REGION (REGION 2)
DENVER, CO

FSH 2509.25 – WATERSHED CONSERVATION PRACTICES HANDBOOK

CHAPTER 10 – MANAGEMENT MEASURES AND DESIGN CRITERIA

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Posting Instructions: Amendments are numbered consecutively by Handbook number and calendar year. Post by document; remove entire document and replace with this amendment. Retain this transmittal as the first page(s) of this document. The last amendment to this Handbook was 2509.25-2006-1 to 2509.25 Zero Code.

New Document(s):	2509.25_10	29 Pages
Superseded Document(s) by Issuance Number and Effective Date	2509.25_10_contents (Amendment 2509.25-96-1, 12/26/1996) 2509.25_10 (Amendment 2509.25-2001-1, 12/18/2001)	1 Page 23 Pages

Digest:

11.1 – Revises the caption from "Standard" to "Management Measure". Adds explanation regarding managing changes in streamflow from natural and anthropogenic disturbance. Adds direction for minimizing Connected Disturbed Areas.

11.2 – Revises the caption from "Standard" to "Management Measure". Revises direction to manage ground cover in an "activity area" rather than a "land unit". Adds direction that amount of ground cover needed is commensurate with site potential.

12 – Revises the caption from "Riparian Areas" to "Riparian Areas and Wetlands".

Digest continued:

12.1 – Revises the caption from "Standard" to "Management Measure". Revises direction for management of livestock grazing in riparian areas and wetlands. Adds direction to emphasize natural processes when restoring streambanks.

12.2 – Revises the caption from "Standard" to "Management Measure". Adds direction that certain situations may require an exception to direction to provide free movement of aquatic life at stream crossings.

12.3 – Revises the caption from "Standard" to "Management Measure". Removes direction to manage toward "robust stream health", but rather to "maintain or improve long-term stream health".

12.4 – Revises the caption from "Standard" to "Management Measure". Removes reference to "404 regulations" in the Management Measure.

12.5 – Revises the caption from "Standard" to "Management Measure". Revises direction from "Return and/or maintain sufficient" to "Manage" stream flows.

12.6 – Revises the caption from "Standard" to "Management Measure". Revises direction for mitigation of water imports to include water disposal and to "maintain or improve long-term stream health" from "is at least 80% of reference conditions". Adds direction for maintenance and operation of water conveyance ditches and pipelines. Adds direction for snow management.

13.1 – Revises the caption from "Standard" to "Management Measure". Revises direction for ground skidding to avoid "sustained" slopes steeper than 40% and "moderate to severely burned sustained slopes greater than 30%". Adds direction to retain drainages and remove outside berms on outsloped roads. Adds direction for location and construction of log landings.

13.2 – Revises the caption from "Standard" to "Management Measure".

13.3 – Revises the caption from "Standard" to "Management Measure". Adds direction regarding operation and maintenance of roads in the winter to protect water quality from de-icers and sedimentation. Adds direction for road surface stabilization and dust abatement to protect water quality.

13.4 – Revises the caption from "Standard" to "Management Measure". Adds direction to restore cuts and fills to the original slope contours where practicable. Adds direction to establish effective ground cover on disturbed sites.

14 – Revises the caption from "Soil Productivity" to "Soil Quality".

Digest continued:

14.1 – Revises the caption from "Standard" to "Management Measure". Revises direction from "limit the sum of severely burned and detrimentally compacted, eroded, and displaced land to no more than 15% of any land unit" to "limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area". Removes reference to wildfire and adds emphasis on restoration to the explanation of the Management Measure. Adds direction to consider snow depths when managing dispersed winter motorized recreation.

14.2 – Revises the caption from "Standard" to "Management Measure". Revises direction for slash retention in harvest units to protect soil quality.

15.1 – Revises the caption from "Standard" to "Management Measure". Adds direction for location of temporary camps to protect water quality.

15.2 – Revises the caption from "Standard" to "Management Measure". Adds direction to prepare Spill Prevention Control and Countermeasure Plans for vehicle service and refueling areas, chemical storage and use areas, and waste dumps. Adds direction to require removal or encapsulation of mine waste material before site reclamation is accepted as final. Adds direction to prevent contaminated runoff from mine waste dumps and tailings piles from reaching surface or ground water. Adds direction to report and clean-up spills in accordance with applicable state and federal laws, rules and regulations.

15.3 – Revises the caption from "Standard" to "Management Measure".

Table of Contents

Management measures are environmental goals to protect soil, aquatic, and riparian systems. Design criteria are specific practices to attain the management measures using current knowledge and technology. Notes following the design criteria cite the effectiveness of the design criteria. The five areas covered are hydrologic function, riparian areas and wetlands, sediment control, soil quality, and water purity.

A 1985 agreement between the Forest Service and the Environmental Protection Agency mandated the Water Resource Evaluation of Nonpoint Silvicultural Sources (WRENSS) as official guidance to control nonpoint sources of water pollution. Its controls were used to construct many management measures and design criteria. Others are adapted from Federal and State BMPs and work of other Regions and agencies. "Best Management Practices" are, by definition, the most effective, practicable means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals (CDPHE, 2001; WY DEQ, 2001).

11 - HYDROLOGIC FUNCTION

Hydrologic function is the ability of a watershed to infiltrate precipitation and naturally regulate runoff so streams are in dynamic equilibrium with their channels and floodplains. Management measures and design criteria to protect hydrologic function apply to all actions that may impact the "sponge and filter" qualities of watersheds. Hydrologic function is protected by maintaining good vegetation and ground cover and by minimizing connected disturbed areas.

11.1 - Management Measure (1)

Manage land treatments to conserve site moisture and to protect long-term stream health from damage by increased runoff.

Land treatments that reduce the evapotranspiration of a watershed or reduce the ability of the watershed to infiltrate and store water will result in an increase in runoff. Land treatments should be implemented in consideration of the ability of the stream to absorb increases in runoff given the effects of the proposed activity in conjunction with other natural or anthropogenic disturbances in the watershed. The ability of a particular stream to be able to accommodate increases in runoff and sediment transport without being damaged depends upon stream type, past disturbances and current stream condition.

Any disturbance that reduces the density of live vegetation cover will increase runoff from forested watersheds. These disturbances can be natural, such as a wildfire or insect and disease outbreaks, or anthropogenic like timber harvest or fuels treatments. In snow dominated areas, flow increases occur mostly during spring runoff on the rising limb of the hydrograph, and are not measurable until about 25 percent of the basal area of a forested watershed is affected. The increase in the size of peak flows is proportional to the amount of basal area affected. However, any reduction in forest cover will have a progressively smaller effect on peak flows with

increasing flow magnitude or recurrence interval. Also, increases in runoff are generally proportional to annual precipitation, that is, greater increases occur in wetter areas. And, the increase in runoff declines over time with vegetation regrowth. Conversely, large openings (opening diameter greater than 15 times the height of surrounding trees) can be subjected to snow scour that can actually reduce site moisture and runoff. (EPA, 1980; MacDonald and Stednick, 2003; Ice and Stednick, 2004).

Increased runoff and sediment caused by soil disturbances are the major source of stream impacts. Roads and other soil disturbances can impair the ability of the land to absorb water and filter sediment. Roads, soil disturbances and vegetation treatments can increase small peak flows and channel erosion, but stream health is not damaged if watershed conservation practices are used. Connected disturbed areas are the main source of damage in all regions (Jones and Grant 1996; Troendle and Olsen 1994; Ziemer 1981).

1. Design Criteria.

   a. In each watershed containing a 3-rd order and larger stream, limit connected disturbed areas so the total stream network is not expanded by more than 10%. Progress toward zero connected disturbed area as much as practicable. Where it is impossible or impracticable to disconnect a particular connected disturbed area, minimize the areal extent of the individual connected disturbed area as much as practicable. In watersheds that contain stream reaches in diminished stream health class, allow only those actions that will maintain or reduce watershed-scale Connected Disturbed Area.

      NOTE: Connected disturbed areas discharge surface water into streams singly or in combination; this measure avoids stream damage from peak flows (Wemple 1994). Stream order is based on the total network of all streams.

   b. Design the size, orientation, and surface roughness (that is. slash and other features that would trap and hold snow on site) of forest openings to prevent snow scour and site desiccation.

      NOTE: WRENSS (III.12 through III.19).

2. Monitoring. Check size and orientation of openings, extent of connected disturbed areas, and stream health (channel widths-depths, substrate, bank stability) of sensitive stream reaches.

3. Restoration. Disconnect disturbed areas from stream networks. Reclaim areas that contribute to excessive runoff and peak flows. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants.

11.2 - Management Measure (2)

Manage land treatments to maintain enough organic ground cover in each activity area to prevent harmful increased runoff.

Organic ground cover (plants, litter, and humus) is vital to maintain hydrologic function. Reduced ground cover decreases infiltration of water and increases surface runoff and peak flows. Continued or severe loss of ground cover often results in the formation of pedestals, rills, and gullies that greatly concentrate runoff, increase peak flows, and damage streams.

1. Design Criteria.

   a. Maintain the organic ground cover of each activity area so that pedestals, rills, and surface runoff from the activity area are not increased. The amount of organic ground cover needed will vary by different ecological types and should be commensurate with the potential of the site.

      NOTE: Such ground cover allows for prescribed fire and site preparation without increasing surface runoff from a 10-year storm (WRENSS II.60; USFS 1966).

   b. Restore the organic ground cover of degraded activity areas within the next plan period, using certified local native plants as practicable; avoid persistent or invasive exotic plants.

      NOTE: Field studies show this to be a reasonable recovery period over a wide range of environments to bring each activity area into compliance.

2. Monitoring. Observe evidence of pedestals, rills, and surface runoff. Compare average organic ground cover of treated activity areas with reference areas, using ocular methods, rooted nested frequency method, cover-frequency method (USFS, 1996a), soil pedon data, pace transects, or other accepted monitoring methods.

3. Restoration. Apply watershed restoration along with land-use controls on degraded lands to disperse runoff and restore organic ground cover with minimum long-term maintenance needs. Reclamation treatments and changes in management may be required. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants.

12 - RIPARIAN AREAS AND WETLANDS

Vegetation next to water bodies plays a major role in sustaining the long-term integrity of aquatic systems (Hynes 1970; Odum 1971). Values provided include shade, bank stability, fish cover, woody debris input, storage and release of sediment, surface-ground water interactions, and habitat for terrestrial and aquatic plants and animals. Riparian zones and wetlands must be managed with care to protect these values.

12.1 - Management Measure (3)

In the water influence zone next to perennial and intermittent streams, lakes, and wetlands, allow only those actions that maintain or improve long-term stream health and riparian ecosystem condition.

The water influence zone (WIZ) includes the geomorphic floodplain (valley bottom), riparian ecosystem, and inner gorge. Its minimum horizontal width (from top of each bank) is the greater of 100 feet or the mean height of mature dominant late-seral vegetation. The WIZ protects interacting aquatic, riparian, and upland functions by maintaining natural processes and resilience of soil, water, and vegetation systems (Reid and Ziemer 1994).

1. Design Criteria.

   a. Allow no action that will cause long-term change to a lower stream health class in any stream reach. In degraded systems (that is At-risk or Diminished stream health class), progress toward robust stream health within the next plan period.

      NOTE: Assess impacts of existing and proposed land treatments in the field before projects begin. Light treatments usually protect stream integrity (WRENSS II.65).

   b. Allow no action that will cause long-term change away from desired condition in any riparian or wetland vegetation community. Consider management of stream temperature and large woody debris recruitment when determining desired vegetation community. In degraded systems, progress toward desired condition within the next plan period.

      NOTE: Desired vegetation condition supports robust stream health (USFS 1996a).

   c. Keep heavy equipment out of streams, swales, and lakes, except to cross at designated points, build crossings, or do restoration work, or if protected by at least 1 foot of packed snow or 2 inches of frozen soil. Keep heavy equipment out of streams during fish spawning, incubation, and emergence periods.

      NOTE: This measure sustains stream and lake integrity (WRENSS II.60).

   d. Ensure at least one-end log suspension in the WIZ. Fell trees in a way that protects vegetation in the WIZ from damage. Keep log landings and skid trails out of the WIZ, including swales.

      NOTE: This measure sustains stream and riparian integrity (WRENSS II.58).

e. Locate new concentrated-use sites outside the WIZ if practicable and outside riparian areas and wetlands. Armor or reclaim existing sites in the WIZ to prevent detrimental soil and bank erosion.

NOTE: WRENSS (II.62), armored water-dependent facilities are excepted.

f. Manage livestock use through control of time/timing, intensity, and duration/frequency of use in riparian areas and wetlands to maintain or improve long-term stream health. Exclude livestock from riparian areas and wetlands that are not meeting or moving towards desired condition objectives where monitoring information shows continued livestock grazing would prevent attainment of those objectives.

g. Keep stock tanks, salt supplements, and similar features out of the WIZ if practicable and out of riparian areas and wetlands always. Keep stock driveways out of the WIZ except to cross at designated points. Armor water gaps and designated stock crossings where needed and practicable.

NOTE: This measure avoids much serious bank damage (Clary and Webster 1989).

h. Manage dry meadow and upland plant communities, including Kentucky bluegrass types, that have invaded into wetland/riparian areas in a manner that will contribute to their replacement over time by more mesic native plant communities to the extent practicable. Develop site-specific riparian stubble height standards or use the following default levels for carex and juncos species: 3-4 inches in spring-use pastures and 4-6 inches in summer or autumn use pastures; to leave adequate residual stubble height to retain effective ground cover.

NOTE: Clary and Webster (1989); USFS (1995); USFS (1996a). Riparian areas with no carex and juncos (for example bluegrass, tufted hairgrass, and so forth) require local stubble heights.

i. Do not allow livestock grazing through an entire growing season in pastures that contain in riparian areas and wetlands. Apply short-duration grazing as practicable (generally less than 20 days) to minimize re-grazing of individual plants, to provide greater opportunity for regrowth and to manage utilization of woody species and reduce soil compaction. During the hot season (mid-to-late summer) manage livestock herds to avoid concentrating in riparian areas and wetlands. Apply principles of the Grazing Response Index to livestock management (USFS, 1996a).

NOTE: USFS (1995).

j. Design grazing systems to limit utilization of woody species. Where woody species have been historically suppressed, or where the plant community is below its desired condition and livestock are a key contributing factor, manage livestock through control of time/timing, intensity, and duration/frequency of use so as to allow for riparian hardwood growth extension and reproduction. Manage woody species in riparian areas to provide for stream temperature, bank stability and riparian habitat.

NOTE: USFS (1995).

k. Maintain the extent of stable banks in each stream reach at 74% or more of reference conditions. Consider degree of livestock trampling and riparian vegetation utilization on or immediately adjacent to stream banks when timing livestock moves between units.

NOTE: USFS (1996a).

l. Adjust management in riparian areas and wetlands to improve detrimental soil compaction whenever it occurs.

NOTE: Hummocking and platy surface soil structure are good indicators of soil compaction if more detailed sampling is not available (BLM 1993, 1994; FSH 2509.18).

m. Do not excavate earth material from, or store excavated earth material in, any stream, swale, lake, wetland, or WIZ.

NOTE: Field studies show such actions can severely damage stream health.

n. Emphasize natural stabilization processes consistent with the stream type and capability (Rosgen and Proper Functioning Condition processes) when restoring damaged stream banks. Use native vegetation for stream bank stabilization whenever practicable.

2. Monitoring. Monitor streambeds and banks, aquatic habitat and biota, soil structure, and riparian vegetation composition and structure.

3. Restoration. Avoid new disturbance until vegetation recovers. Stabilize stream and lake banks with certified local native plants as practicable; avoid persistent or invasive exotic plants. Restore aquatic habitat. Relocate heavy-use sites. Disconnect or armor disturbed areas. Rest degraded areas from disturbance if needed.

12.2 - Management Measure (4)

Design and construct all stream crossings and other instream structures to provide for passage of flow and sediment, withstand expected flood flows, and allow free movement of resident aquatic life.

Corps of Engineers and Forest Service design criteria are combined to ensure that all facilities remain stable, not necessarily pass the entire flood flow. Structures must sustain long-term channel integrity, pass design flows with expected debris or be armored to withstand the design flood (not wash out) during their design life, and allow unimpeded movement of aquatic life.

Culverts often concentrate flow and increase depth and velocity to a maximum just before spilling onto the streambed. Scour pools are common below outlets and migration can be impaired if water velocity or drop is excessive. Check crossings for problems and repair them if needed.

The need for providing passage for aquatic life or creating a barrier to movement is determined on a site-specific basis. In general, in-stream structures should provide for unimpeded movement of resident aquatic life. However, in certain situations, such as to protect a genetically pure population of native fish or other aquatic species, there may be a need to restrict passage.

1. Design Criteria.

   a. Install stream crossings to meet Corps of Engineers and State permits, pass normal flows, and be armored to withstand design flows.

   b. Size culverts and bridges to pass debris. Engineers work with hydrologists and aquatic biologists on site design.

      NOTE: WRENSS (II.61, II.65).

   c. Install stream crossings on straight and resilient stream reaches, as perpendicular to flow as practicable, and to provide passage of fish and other aquatic life.

      NOTE: Maintaining channel geometry and hydraulics protects fish passage (WRENSS II.60; Baker and Votapka 1990).

   d. Install stream crossings to sustain bankfull dimensions of width, depth, and slope and keep streambeds and banks resilient. Favor bridges, bottomless arches or buried pipe-arches for those streams with identifiable flood plains and elevated road prisms, instead of pipe culverts. Favor armored fords for those streams where vehicle traffic is either seasonal or temporary, or the ford design maintains the channel pattern, profile and dimension.

      NOTE: Temporary bridges or vented fords (fords with pipes to pass low flows) are potential options where appropriate depending upon traffic use. Temporary

bridges should be installed and removed seasonally. Temporary fords should be removed when the need for the crossing no longer exists. Pipe culverts pose the most risk of channel damage, migration blockage, and sediment, while fords can impact incised channels (WRENSS II.57; Terrene Institute 1994; Bohn 1998).

e. Install or maintain fish migration barriers only if needed to protect endangered, threatened, sensitive, or unique native aquatic populations, and only where natural barriers do not exist.

NOTE: Many barriers have disrupted natural distributions of fish populations.

2. Monitoring. Check stability and grade of crossings, capacity of channels, sediment deposits in streambeds, and ability of aquatic biota to pass (40 CFR 230.23 and 230.31).

3. Restoration. Replace problem culverts with bridges, fords, or arches to provide bed and bank stability and movement of aquatic life.

12.3 - Management Measure (5)

Conduct actions so that stream pattern, geometry, and habitats maintain or improve long-term stream health.

Stream health depends much on channel widths and depths, bank stability, and quality of cover and substrate. In-channel work can directly impact stream channel morphology. Other actions, such as snowmaking or water depletions, can indirectly affect channel morphology by changing (either increasing or decreasing) flow.

1. Design Criteria.

a. Add or remove rocks, wood, or other material in streams or lakes only if such action maintains or improves stream and lake health. Leave rocks and portions of wood that are embedded in beds or banks to prevent channel scour and maintain natural habitat complexity.

NOTE: Structural complexity provided by rocks, wood, and other elements is vital to maintain channel resilience and habitat features for aquatic biota. Excessive input or removal can damage stream health (Dunne and Leopold 1978, page 709).

b. Do not relocate natural stream channels if avoidable. Return flow to natural channels where practicable. Where reconstruction of stream channels is necessary, construct channels and floodways with natural stream pattern and geometry, stable beds and banks and provide habitat complexity.

NOTE: Dunne and Leopold (1978, page 709).

2. Monitoring. Monitor channel pattern, geometry, and stability; migration barriers; and aquatic habitat and biota.

3. Restoration. Restore degraded streams to robust stream health with minimum long-term maintenance needs, as part of whole watershed restoration programs that permanently cure causes of damage. Install or remove rocks, wood, or other structures only as a last resort to restore robust stream health. Plant certified local native plants, as practicable, to restore bank stability and cover; avoid persistent or invasive exotic plants.

12.4 - Management Measure (6)

Maintain long-term ground cover, soil structure, water budgets, and flow patterns of wetlands to sustain their ecological function.

Wetlands control runoff and water quality, recharge ground water, and provide abundant and diverse biota. Natural patterns and processes must be protected. Executive Order 11990 directs that impacts to wetlands should be avoided, minimized or mitigated where practicable. The Corps of Engineers protects wetlands under Section 404 regulations, which may permit wetland impacts if mitigation measures are applied to replace wetland values in-kind.

1. Design Criteria.

a. Keep ground vehicles out of wetlands unless protected by at least 1 foot of packed snow or 2 inches of frozen soil. Do not disrupt water supply or drainage patterns into wetlands.

NOTE: Field studies show this measure protects soil structure and water regimes.

b. Keep roads and trails out of wetlands unless there is no other practicable alternative. If roads or trails must enter wetlands, use bridges or raised prisms with diffuse drainage to sustain flow patterns. Set crossing bottoms at natural levels of channel beds and wet meadow surfaces. Avoid actions that may dewater or reduce water budgets in wetlands.

NOTE: Terrene Institute (1994).

c. Avoid long-term reduction in organic ground cover and organic soil layers in any wetland (including peat in fens).

NOTE: Field studies show this measure protects vital ecological functions.

d. When practicable, keep buried utility and pipelines out of wetlands. If such a line must enter a wetland, use measures that sustain long-term wetland function.

NOTE: This measure is needed to avoid subsurface wetland damage.

e. Avoid any loss of rare wetlands such as fens and springs.

NOTE: These wetlands cannot be replaced in-kind.

f. Do not build firelines in or around wetlands unless needed to protect life, property, or wetlands. Use hand lines with minimum feasible soil disturbance. Use wetland features as firelines if practicable.

NOTE: This measure protects drainage patterns and prevents fireline scars that are often slow to heal in wetlands (USFS 1990, page II-51).

2. Monitoring. Monitor integrity of organic ground cover and organic soil layers, plant community composition and structure, soil structure, water levels, and drainage patterns.

3. Restoration. Retrofit crossings to restore water levels and drainage (Terrene Institute 1994). Reclaim wetlands to restore physical and biological functions. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants.

12.5 - Management Measure (7)

Manage stream flows under appropriate authorities to minimize damage to scenic and aesthetic values, fish and wildlife habitat, and to otherwise protect the environment.

Aquatic ecosystems make up only about 5% of the NFS lands in the Region, but almost half of the imperiled species are aquatic dependent. Stream flow regimes are critical to maintaining stream processes, aquatic life and habitat. Work to protect current stream flow dependent water uses and improve conditions in perennial streams where stream flow regimes have been altered.

Streamflow protection may be a condition of permitting occupancy and use of NFS lands. Cooperation with water users and others is necessary to ensure appropriate resource protection while meeting the needs of people who have valid existing water rights. State instream flow programs will be used where possible when they meet NFS needs.

1. Design Criteria.

a. Cooperate with water users and other interested parties to evaluate how to operate existing water use facilities to meet resource goals.

b. Obtain stream flows under appropriate federal and state, legal and regulatory authorities to protect stream processes, aquatic and riparian habitats and communities, and recreation and aesthetic values. Top priority is to protect imperiled native species. Generally, this will include a range of flows to support desired uses and values.

c. Upon issuance of special use authorizations for new or existing water use facilities, include permit conditions at the point of diversion or storage, if needed, to minimize impacts to water dependent resources and values. One or more of the following circumstances may be present in any given project. Water dependent resources and values not included on this list may require additional consideration.

(1) When managing for physical stream processes, including channel maintenance, evaluate each stream on which a project is planned to ascertain what flows represent the amounts and timing needed to sustain these functions. Essential attributes of a properly functioning self-maintaining channel include providing for flows to achieve the following:

(a) Move the mass and sizes of alluvial sediment supplied to the channel.

(b) Maintain channel capacity by preventing terrestrial vegetative growth in the bed of the channel.

(c) Protect and sustain channel banks and the floodplain by maintaining healthy streamside vegetation.

(d) Maintain processes that sustain the relationship between the channel and the floodplain.

(2) When managing for aquatic biota and their habitat, evaluate each stream upon which a project is planned to ascertain what flows represent the amounts and timing needed to sustain viability of existing populations of native and desired non-native vertebrate species**.** Essential flow related attributes of sustainable habitat should achieve the following:

(a) Maintain the physical, biological, and chemical processes necessary for all life-history stages of identified species and communities.

(b) Minimize the impact of dams and diversion structures on the interaction between populations.

(c) Return flows to historic habitat where reintroduction potential exists.

(3) When managing for riparian habitat and communities, evaluate each stream upon which a project is planned to ascertain what flows and timing are needed to maintain or improve riparian habitat and community structure and function. These flows should be adequate to:

(a) Maintain the physical, biological, and chemical processes necessary to ensure the sustainability and ecological integrity of identified species and communities.

(b) Maintain the magnitude, variability, and frequency of disturbance processes that affect community structure and function.

(4) When managing for aesthetic and recreational values, evaluate each stream upon which a project is planned to ascertain what flows and timing represent the amounts and period needed to sustain these values. These flows should be adequate to:

(a) Support flow dependent recreation uses (for example, rafting, kayaking, swimming).

(b) Maintain desired populations of fish species to provide for appropriate recreational experiences.

(c) Provide water for aesthetic enjoyment.

(d) Support special designations, including Wild and Scenic Rivers, where flowing water is critical to the purpose and quality of the designation.

d. Obtain water rights under federal and state law to protect stream processes, aquatic and riparian habitats and communities, and recreation and aesthetic values. Top priority is to protect imperiled native species.

NOTE: FSM 2540

2. Monitoring. Monitor stream flow, stream health, and riparian condition.

3. Restoration. In cases of noncompliance with permit conditions, pursue suspension or revocation provisions contained in the authorization. Explore joint operation plans for related water facilities to protect instream values with least impact to water users.

12.6 - Management Measure (8)

Manage water-use facilities to prevent gully erosion of slopes and to prevent sediment and bank damage to streams.

Clean Water Act Section 304(f)(2) addresses control of pollution caused by dams and flow diversion facilities. Facilities include diversion and discharge structures, ditches, and pipes. Other activities, such as coal-bed methane production or snowmaking at ski areas, can generate large volumes of water that may exceed the assimilative capacity of receiving streams. Protect slope, stream stability and aquatic habitat as much and as early as practicable (Section 319(a)).

1. Design Criteria.

   a. Design all ditches, canals, and pipes with at least an 80% chance of passing high flows and remaining stable during their life.

      NOTE: This measure minimizes pipe breaks and ditch failures that cause gullies and landslides which add huge sediment loads to streams.

   b. Do not flush or deposit sediment from behind diversion structures into the stream below. Deposit sediment in a designated upland site. Vegetate or otherwise stabilize spoil piles.

      NOTE: Adding sediment to a stream that no longer has the capacity to transport it creates long-term stream damage (40 CFR 230) that often includes bank failure.

   c. Mitigate water imports and water disposal (including reservoir releases) so that the extent of stable banks, channel pattern, profile and dimensions maintain or improve long-term stream health in each receiving stream reach.

      NOTE: Water imports that increase the size or duration of high flows have damaged streams through major bank erosion. This measure prevents such severe damage.

   d. Maintain and operate water conveyance ditches and pipelines to carry their design volumes of water with appropriate freeboard. Keep ditches clear of vegetation, debris or other obstructions to minimize potential for ditch failures.

   e. Conduct snow management, including snowmaking and snow-farming, in such a manner that prevents slope failures and gully erosion on the hillslopes and prevents adverse impacts, such as bank erosion and excessive sediment, in receiving streams.

2. Monitoring. Monitor stream health below diversion and discharge structures. Check prompt remediation of water pipeline breaks and ditch failures. Inspect each facility in the field at least once every two years to conform to the biennial reporting provisions of Clean Water Act Section 319(m).

3. Restoration. Require performance bonds for potential repair of ditches and streams. Stop operation of facilities that do not comply with design criteria until compliance occurs.

Stabilize ditch berms and gullies. Restore ground cover using certified local native plants as practicable; avoid persistent or invasive exotic plants. Remove sediment from streams. Stabilize streams to move them toward robust stream health.

13 - SEDIMENT CONTROL

Most sediment delivered from slopes to streams comes from roads and similar disturbed sites. Management measures and design criteria to control sediment come from Clean Water Act Section 404 mandatory BMPs (33 CFR 323.4), EPA and State BMPs, and WRENSS controls. The goal is antidegradation and no impairment.

13.1 - Management Measure (9)

Limit roads and other disturbed sites to the minimum feasible number, width, and total length consistent with the purpose of specific operations, local topography, and climate.

Keep the number of stream crossings and the extent of sediment sources to a practicable minimum. Avoid sediment loads that damage stream health.

1. Design Criteria.

   a. Construct roads on ridge tops, stable upper slopes, or wide valley terraces if practicable. Stabilize soils onsite. End-haul soil if full-bench construction is used. Avoid slopes steeper than 70%.

      NOTE: Roads on favorable terrain cause little sediment (WRENSS V.29, V.35).

   b. Avoid soil-disturbing actions during periods of heavy rain or wet soils. Apply travel restrictions to protect soil and water.

      NOTE: This measure reduces mobilized soil during runoff events (WRENSS II.56).

   c. Install cross drains to disperse runoff into filter strips and minimize connected disturbed areas. Make cuts, fills, and road surfaces strongly resistant to erosion between each stream crossing and at least the nearest cross drain. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants.

      NOTE: Cross drains near crossings, well-revegetated cuts and fills, and surfacing with large (1 to 3 inch), angular, well-graded gravel greatly reduce sediment from connected disturbed areas (Burroughs and King 1989; Kochenderfer et al. 1984; Swift 1984).

d. Construct roads where practicable, with outslope and rolling grades instead of ditches and culverts.

NOTE: Kochenderfer et al. (1984); Swift (1984).

e. Retain stabilizing vegetation on unstable soils. Avoid new roads or heavy equipment use on unstable or highly erodible soils.

NOTE: WRENSS (II.58, II.60).

f. Use existing roads unless other options will produce less long-term sediment. Reconstruct for long-term soil and drainage stability.

NOTE: Reusing old roads usually produces less sediment, but it is often best to reclaim old roads near streams and build farther upslope.

g. Avoid ground skidding on sustained slopes steeper than 40% and on moderate to severely burned sustained slopes greater than 30%. Conduct logging to disperse runoff as practicable.

NOTE: This measure promotes filtration of runoff and sediment (WRENSS II.61).

h. Designate, construct, and maintain recreational travelways for proper drainage and armor their stream crossings as needed to control sediment.

NOTE: Uncontrolled OHV and other recreational use, especially in wet conditions, can severely damage streams and riparian areas.

i. During and following operations on outsloped roads, retain drainage and remove berms on the outside edge except those intentionally constructed for protection of road grade fills.

j. Locate and construct log landings in such a way to minimize the amount of excavation needed and to reduce the potential for soil erosion. Design landings to have proper drainage. After use, treat landings to disperse runoff and prevent surface erosion and encourage revegetation.

2. Monitoring. Monitor travelway conditions, sediment movement into streams, and sediment effects on aquatic habitat and biota.

3. Restoration. Disconnect disturbed areas from streams. Stabilize slopes and surface roads. Close and reclaim roads using certified local native plants as practicable; avoid persistent or invasive exotic plants. Restore integrity of streams and their aquatic habitats.

13.2 - Management Measure (10)

Construct roads and other disturbed sites to minimize sediment discharge into streams, lakes, and wetlands.

Excessive sediment from roads and other disturbed sites can have adverse effects on aquatic habitat. Projects that avoid water bodies or discharge into filter strips are usually less expensive than those that use constructed sediment traps. Sediment control has been effective with common watershed conservation practices in all regions.

1. Design Criteria.

   a. Design all roads, trails, and other soil disturbances to the minimum standard for their use and to "roll" with the terrain as feasible.

      NOTE: Field studies show that following terrain contours reduces cuts and fills.

   b. Use filter strips, and sediment traps if needed, to keep all sand-sized sediment on the land and disconnect disturbed soil from streams, lakes, and wetlands. Disperse runoff into filter strips.

      NOTE: Burroughs and King (1989); WRENSS (II.64).

   c. Key sediment traps into the ground. Clean them out when 50% full. Remove sediment to a stable, gentle, upland site and revegetate.

      NOTE: Field studies show that good sediment traps enhance filter strips.

   d. Keep heavy equipment out of filter strips except to do restoration work or build armored stream or lake approaches. Yard logs up out of each filter strip with minimum disturbance of ground cover.

      NOTE: Field studies show this measure protects filter strip integrity.

   e. Build firelines outside filter strips unless tied into a stream, lake, or wetland as a firebreak with minimal disturbed soil. Retain organic ground cover in filter strips during prescribed fires.

      NOTE: Light burns protect the ground cover of filter strips (USFS 1990).

   f. Design road ditches and cross drains to limit flow to ditch capacity and prevent ditch erosion and failure.

      NOTE: WRENSS (II.56, II.58); Burroughs and King (1989).

2. Monitoring. Monitor sediment movement into streams and sediment effects on aquatic habitat and biota.

3. Restoration. Add cross drains and sediment traps to improve filter strips. Revegetate disturbed areas using certified local native plants as practicable; avoid persistent or invasive exotic plants. Restore integrity of streams and their aquatic habitats.

13.3 - Management Measure (11)

Stabilize and maintain roads and other disturbed sites during and after construction to control erosion.

Build erosion resistance into project design to reduce costly maintenance and restoration (Clean Water Act Sections 402(p) and 404). Mitigate concurrently with construction. Obtain stormwater (402) and 404 permits as required.

1. Design Criteria.

a. Do not encroach fills or introduce soil into streams, swales, lakes, or wetlands.

NOTE: Corps of Engineers nationwide permits (33 CFR 330) limit fill in streams.

b. Properly compact fills and keep woody debris out of them. Revegetate cuts and fills upon final shaping to restore ground cover, using certified local native plants as practicable; avoid persistent or invasive exotic plants. Provide sediment control until erosion control is permanent.

NOTE: Burroughs and King (1989); WRENSS (II.63, V.29, V.35).

c. Do not disturb ditches during maintenance unless needed to restore drainage capacity or repair damage. Do not undercut the cut slope.

NOTE: Burroughs and King (1989); WRENSS (II.56, II.58, II.63).

d. Space cross drains according to road grade and soil type as indicated below: (ex. 01). Do not divert water from one stream to another.

NOTE: Kochenderfer et al. (1984); Swift (1984); WRENSS (II.64) SDSU et. al. (2003).

e. Empty cross drains onto stable slopes that disperse runoff into filter strips. On soils that may gully, armor outlets to disperse runoff. Tighten cross-drain spacing so gullies are not created.

NOTE: Avoid streamheads, unstable soils, and highly erodible soils (Burroughs and King 1989; WRENSS II.56, II.58, II.59, II.63, II.64).

f. Armor rolling dips as needed to prevent rutting damage to the function of the rolling dips. Ensure that road maintenance provides stable surfaces and drainage.

NOTE: Burroughs and King (1989); WRENSS (II.64).

13.3 - Exhibit 01
Maximum Cross-Drain Spacing in Feet Based on Soil Types*****

	Unified Soil Classification - ASTM D 2487			
Road Grade (%)	ML, SM Extr. Erodible Silts-sands with little or no binder (d.g.)	MH, SC, CL Highly Erodible Silts-sands with moderate binder	SW,SP,GM,GC Mod. Erodible Gravels + fines & sands with little or no fines	GW,GP Low Erodible Gravels with little or no fines
1-3	600	1000	1000	1000
4-6	300	540	680	1000
7-9	200	360	450	670
10-12	150	270	340	510
13-15	120	220	270	410

*****Adapted from original work on the Siuslaw National Forest documented in the Transportation Engineering Handbook of the Pacific Northwest Region, 1966. Original spacings were based on rainfall intensities of 1 to 2 inches per hour falling in 15 minutes. Soil groups and spacings have been modified, based partly on ditch erosion information in WRENSS, to better represent climate and soil regimes found in the Rocky Mountain Region.

These are maximum spacings. They should be reduced if warranted by onsite factors such as expected road use, downslope stability and erosion hazards, and filter strip capability to trap runoff and sediment and conserve ground cover integrity given the extra water. Combine these spacings with common sense to place cross drains where damage to ditches, slopes, and streams will be minimized. For example, shorten or extend the spacing where needed to move a cross-drain outlet from a stream headwall to a convex slope.

g. Where berms must be used, construct and maintain them to protect the road surface, drainage features, and slope integrity while also providing user safety.

NOTE: Roadside berms can channel runoff down the road (Burroughs and King 1989). Use of shoes on snowplow blades protects surfaces.

h. Build firelines with rolling grades and minimum downhill convergence. Outslope or backblade, permanently drain, and revegetate firelines immediately after the burn. Use certified local native plants as practicable; avoid persistent or invasive exotic plants.

NOTE: WRENSS (II.56, II.61).

i. Use the minimum amount of sand, salt, and/or other de-icing substances (Mag-Chloride) as necessary to provide safe winter travel conditions. Design paved roads and parking lots to facilitate sand removal (that is curbs or paved ditches). Use filter strips or other trapping methods to reduce movement of de-icing materials into near-by water bodies. Do not deposit sediment into streams or on streambanks along roads.

j. During winter operations, maintain roads as needed to keep the road surface drained during thaws and break-ups. Perform snow removal in such a manner that protects the road and other adjacent resources. Do not use riparian areas, wetlands or streams for snow storage or disposal. Remove snow berms where they result in accumulation or concentration of snowmelt runoff on the road or erodible fill slopes. Install snow berms where such placement will preclude concentration of snowmelt runoff and will serve to rapidly dissipate melt water.

k. On roads with high/heavy traffic use, require maintenance agreements and/or use of road surface stabilization practices and dust abatement supplements. See FSH 7709.56 and FSH 7709.58.

2. Monitoring. Monitor condition of cuts, fills, and ditches, effectiveness of filter strips, and runoff and sediment dispersion below cross drains. Monitor sediment movement into streams and sediment effects on aquatic habitat and biota.

3. Restoration. Stabilize fills, ditches, and cross drains. Add cross drains. Repair and armor surfaces subject to ruts. Restore integrity of streams and their aquatic habitats.

13.4 - Management Measure (12)

Reclaim roads and other disturbed sites when use ends, as needed, to prevent resource damage.

Restoring stable grades, stable drainage, and ground cover are critical to reclaiming disturbances and protecting soil quality and stream health. Roads in riparian areas and wetlands should be the highest priority for restoration.

1. Design Criteria.

a. Site-prepare, drain, decompact, revegetate, and close temporary and intermittent use roads and other disturbed sites within one year after use ends. Provide stable drainage that disperses runoff into filter strips and maintains stable fills. Do this work concurrently. Stockpile topsoil where practicable to be used in site restoration. Use certified local native plants as practicable; avoid persistent or invasive exotic plants.

NOTE: WRENSS (II.57, II.58), USFS (1996b). One year allows revegetation in optimum seasons.

b. Remove all temporary stream crossings (including all fill material in the active channel), restore the channel geometry, and revegetate the channel banks using certified local native plants as practicable; avoid persistent or invasive exotic plants.

c. Restore cuts and fills to the original slope contours where practicable and as opportunities arise to re-establish subsurface pathways. Use certified local native plants as practicable; avoid persistent or invasive exotic plants. Obtain stormwater (402) discharge permits as required.

d. Establish effective ground cover on disturbed sites to prevent accelerated on-site soil loss and sediment delivery to streams. Restore ground cover using certified native plants as practicable to meet revegetation objectives. Avoid persistent or invasive exotic plants.

2. Monitoring. Monitor connected disturbed areas and culverts removed.

3. Restoration. Reclaim remaining sediment sources. Provide stable drainage that disconnects as much disturbed area as practicable. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants.

14 - SOIL QUALITY

Soil quality determines vegetation growth capability in all terrestrial ecosystems. Soil depth, structure, organic matter, and nutrients are critical to sustaining this potential. Management measures and design criteria to protect soil quality apply to all actions that may impact these soil qualities.

14.1 - Management Measure (13)

Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area.

Severe burns kill soil biota, alter soil structure, consume litter and humus, and remove organic matter and nutrients. Severe fires occur when humus and large fuels are dry and heavy fuels near the ground conduct much heat into the soil. Recovery takes years (USFS 1990).

Soil compaction is caused by the weight of vehicles and animals on the ground. It increases soil density and reduces large pores so that water absorption and root growth are impaired. Clay and loam soils compact more than sandy soils. Soils compact more when soil moisture exceeds the plastic limit. Detrimental compaction may occur with few passes in moist soils but may take many passes in dry soils. Ground cover, deep snow, and frozen soil reduce compaction. Severe compaction can extend to two feet in roads, major skid trails, and log decks; tree growth may be greatly reduced and recovery may take decades (USFS 1990).

The 15% limit applies to all natural and human disturbances that may impact soil structure, organic matter, and nutrients in areas allocated for vegetation production (R2 FSH 2509.18). Where excessive soil impacts already exist from prior activity, the emphasis should be on preventing any additional detrimental impacts and on reclamation where practicable. As defined in the National Soil Handbook (FSH 2509.18) soil quality standards are intended for areas where management prescriptions are being applied, such as timber harvest areas and range allotments. They are not intended to apply to administrative sites or other areas with dedicated uses such as the permanent transportation system, well pads or ski areas, for example.

1. Design Criteria.

   a. Restrict roads, landings, skid trails, concentrated-use sites, and similar soil disturbances to designated sites.

      NOTE: FSH 2509.18; WRENSS (V.29, V.35).

   b. Operate heavy equipment for land treatments only when soil moisture is below the plastic limit, or protected by at least 1 foot of packed snow or 2 inches of frozen soil.

      NOTE: This measure limits compaction. Soil moisture exceeds the plastic limit if the soil can be rolled into 3 mm threads without breaking or crumbling.

   c. Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives. This is usually done when the soil and duff are moist.

      NOTE: This measure prevents severe soil heating (USFS 1990, page IV-90).

   d. Allow dispersed winter motorized recreation when snow depths are sufficient to protect soils. Specify a minimum unpacked snow depth of 12 inches unless a site-specific analysis shows a different snow depth is adequate to protect soils. Allow use of snowcats or grooming machines when unpacked snow depths equal or exceed 18 inches. Evaluate special use permit conditions on a site specific basis.

2. Monitoring. Monitor extent of severely burned and detrimentally compacted, displaced, and eroded soil in those activity areas with the most disturbances.

3. Restoration. Subsoil and till to mitigate detrimental compaction. Seed, fertilize, and mulch severe burns. Use certified local native plants as practicable; avoid persistent or invasive exotic plants. Close and reclaim, or permanently armor, any site that has soil pedestals or rills and is subject to concentrated use.

14.2 - Management Measure (14)

Maintain or improve long-term levels of organic matter and nutrients on all lands.

Nutrient loss occurs when organic matter and nutrients contained in leaves, limbs, litter, humus, and topsoil is moved offsite. Bole-only timber harvest and careful slash piling that keeps soil in place minimizes loss (USFS 1990).

Careless piling that moves topsoil may remove much nitrogen and other nutrients from the site. Long-term soil productivity is reduced because organic matter that supplies nutrients over time is displaced offsite (USFS 1990).

Total-tree harvest removes the whole above-stump tree from the site. Loss of nitrogen and other nutrients can be several times that with bole-only harvest (Woodard 1993). Nutrient studies show that soil productivity may be reduced by one total-tree clearcut in poor soils and repeated clearcuts in rich soils. However, total-tree harvest may be necessary to reduce fuel loadings, prevent soil damaging high severity fires and restore natural disturbance regimes.

1. Design Criteria.

   a. On soils with surface soil (A-horizon) thinner than 1 inch, topsoil organic matter less than 2%, or effective rooting depth less than 15 inches, retain 80 - 90% of the fine (less than 3 inches in diameter) post treatment logging slash in the stand after each clearcut and seed-tree harvest. Consider need for retention of coarse woody debris slash in each activity area to balance soil quality requirements and fuel loading concerns.

      NOTE: Base this measure strictly on onsite soil investigations, NRCS (SCS, 1993) rating for whole tree harvesting and slash levels. Exceptions may occur when high fire hazard overrides the need to leave slash onsite. Apply this measure to complement site regeneration.

   b. If machine piling of slash is done, conduct piling to leave topsoil in place and to avoid displacing soil into piles or windrows.

      NOTE: USFS (1990, pages II-25, II-54, IV-91).

2. Monitoring. Monitor slash and litter removal, and soil in piles and windrows.

3. Restoration. Return slash to the site, fertilize, or add sludge to restore site organic matter and nutrients; avoid persistent or invasive exotic plants.

15 - WATER PURITY

Chemicals and pathogens impact water purity. Management measures and design criteria to protect water purity intend to avoid contamination of all waters.

15.1 - Management Measure (15)

Place new sources of chemical and pathogenic pollutants where such pollutants will not reach surface or ground water.

Chemicals and pathogens can travel long distances in water. Pollutants must be filtered out before they reach surface or ground water.

1. Design Criteria.

   a. Locate pack and riding stock sites (for example corrals and loading areas), sanitary sites, and well drill-pads outside the water influence zone (WIZ).

      NOTE: This measure and those under section 12.1 minimize water pollution. Some minor bacterial input from dispersed livestock and wildlife use is unavoidable.

   b. Locate vehicle service and fuel areas, chemical storage and use areas, and waste dumps and areas on gentle upland sites. Mix, load, and clean on gentle upland sites. Dispose of chemicals and containers in State-certified disposal areas.

      NOTE: Keep such sites out of valley bottoms due to mobility of many chemicals.

   c. Locate temporary labor, spike, logging and fire camps such that surface and subsurface water resources are protected. Consideration should be given to disposal of human waste, wastewater and garbage and other solid wastes.

2. Monitoring. Monitor water quality and location of pollutant sources.

3. Restoration. Move pollutants to State-certified disposal areas. Reclaim source areas. Remove contaminated sediments from waters.

15.2 - Management Measure (16)

Apply runoff controls to disconnect new pollutant sources from surface and ground water.

Even favorably located pollutant sources need controls to trap pollutants during major runoff events. Keep discharges free from toxic pollutants in toxic amounts.

1. Design Criteria.

   a. Install contour berms and trenches around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills. Use liners as needed to prevent seepage to ground water. Prepare Spill Prevention Control and Countermeasure Plan per the requirements of 40 CFR 112.

      NOTE: Standard contingency runoff control for chemical use and storage sites.

   b. Reclaim each mine waste dump when its use ends, using certified local native plants as practicable; avoid persistent or invasive exotic plants. Stabilize waste dumps and tailings in non-use periods to prevent wind and water erosion. If non-use will exceed one year, perform concurrent reclamation. Require removal or encapsulation of waste material as necessary to prevent contamination of nearby water bodies before operator abandons site or reclamation is accepted as final.

      NOTE: Avoid unreclaimed pollution sources throughout a watershed.

   c. Prevent contaminated runoff from waste dumps and/or tailings from reaching surface and/or ground water. Potential techniques include use of lined ponds to catch runoff, diversion ditches or other runoff controls to divert runoff around waste dumps/tailings piles, capping or treating waste piles on site or off-site disposal of waste as appropriate. If ponds are used, build tailings dams with a 95% chance of containing floods (100-year event) over their design life. Permanently stabilize dams at final shaping.

      NOTE: Lined ponds are a standard practice on new mines. Use clay plus synthetic liners if the pond will hold known chemicals. Geotechnical engineers must approve all designs.

   d. Clean wastewater from concrete batching and aggregate operations before returning the water to streams, lakes, or wetlands.

      NOTE: Needed to prevent major sediment and cementation impacts in streambeds.

   e. Inspect equipment used for transportation, storage or application of chemicals daily during use period for leaks. If leaks or spills occur, report them and install emergency traps to contain them and clean them up. Refer to FSH 6709.11, chapter 60 for direction on working with hazardous materials.

NOTE: Standard practice for pesticide equipment (USFS 1990, page II-60).

f. Report spills and take appropriate clean-up action in accordance with applicable state and federal laws, rules and regulations. Contaminated soil and other material shall be removed from NFS lands and disposed of in a manner according to state and federal laws, rules and regulations.

2. Monitoring. Monitor water quality and status of runoff controls.

3. Restoration. Move pollutants to State-certified disposal areas. Reclaim source areas using certified local native plants as practicable; avoid persistent or invasive exotic plants. Remove contaminated sediments from waters.

15.3 - Management Measure (17)

Apply chemicals using methods that minimize risk of entry to surface and ground water.

Pollution risk depends on chemical mobility and persistence, application mode and rate, and distance from water (USFS 1990). Risk of entry to surface water is highest for broadcast and aerial treatments and for fine droplets. Risk of entry to ground water is highest over sandy soils and shallow water tables.

1. Design Criteria.

a. Favor pesticides with half-lives of 3 months or less when practicable to achieve treatment objectives.. Apply at lowest effective rates as large droplets or pellets. Follow the label directions. Favor selective treatment. Use only aquatic-labeled chemicals in the WIZ.

NOTE: Standard practice for pesticides (USFS 1990, pages II-55 to II-60).

b. Use non-toxic, non-hazardous drilling fluids when practicable.

NOTE: Standard practice for oil and gas drilling operations. Oil-based drilling fluids are required for deep wells.

2. Monitoring. Monitor vegetation near water and chemicals in water.

3. Restoration. Remove or neutralize contaminants or avoid further application.